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TITLE: Time domain equalization for discrete multi-tone systems

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INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Harikumar; Gopal	Norwood	MA	N/A	N/A
Marchok; Daniel J.	Buchanan	MI	N/A	N/A
Rudofski; Kenneth J.	Chicago	IL	N/A	N/A

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CLAIMS:

What is claimed is:

1. A method for adapting a primary impulse shortening filter in a multiple carrier communication system, the method comprising: providing a secondary impulse shortening filter, comparing an output signal of the secondary impulse shortening filter to a reference signal to compute an error signal, computing coefficients of the secondary impulse shortening filter in an adaptive processor based on the error signal, and replacing coefficients of the primary impulse shortening filter with coefficients of the secondary impulse shortening filter.

2. The method of claim 1, further comprising: decoding an output signal of the primary impulse shortening filter to form output data, and encoding the output data to form the reference signal.

3. The method of claim 2, further comprising applying a discrete Fourier transform to the output signal of the primary impulse shortening filter prior to decoding the output signal.

4. The method of claim 2, further comprising applying an inverse discrete Fourier transform to the encoded output data in forming the reference signal.

5. The method of claim 1, further comprising: receiving a digital signal from an output of an analog to digital converter, applying the digital signal to the primary impulse shortening filter, delaying the digital s,ignal to produce a delayed digital signal, applying the delayed digital signal to the secondary impulse shortening filter, and applying the delayed digital signal to

the adaptive processor.

6. The method of claim 2, further comprising scaling the encoded output data with a set of scaling factors in forming the reference signal.

7. The method of claim 6, wherein the scaling factors are determined by: measuring received noise;power spectral density, computing a desired spectral response based on the measured noise power, and computing the scaling factors so that the coefficients computed in the adaptive processor provide the secondary impulse shortening filter with a spectral response that matches the desired spectral response.

8. The method of claim 7, further comprising applying a discrete Fourier transform to the output signal of the,primary impulse shortening filter prior to decoding the output signal and measuring the noise power spectral density at an output of the discrete Fourier transform.

9. The method of claim 6, further comprising applying an inverse discrete Fourier transform to the scaled, encoded output data.

10. A method for adapting an impulse shortening filter in a multiple carrier communication system having a spectrally constrained impulse shortening filter, the method comprising: scaling predetermined reference values with a set of scaling factors to form scaled values, applying an inverse discrete Fourier transform to the scaled values to form a reference signal, comparing an output signal of the spectrally constrained impulse shortening filter to the reference signal to compute an error signal, and computing coefficients of the spectrally constrained impulse shortening filter in an adaptive processor based on the error signal.

11. The method of claim 10, wherein the scaling factors are determined by: measuring received noise power spectral density, computing a desired spectral response based on the measured noise power, and computing the scaling factors so that the coefficients computed in the adaptive processor provide a secondary impulse shortening filter with the desired spectral response.

12. The method of claim 10 further comprising: receiving a data signal from an output of an analog to digital converter, applying the data signal to the spectrally constrained impulse shortening filter, and applying the data signal to the adaptive processor.

13. A method for adapting an impulse shortening filter in a multiple carrier communication system having a spectrally constrained impulse shortening filter, the method comprising: receiving a digital signal, applying the digital signal to the spectrally constrained impulse shortening filter to obtain a first output signal, computing a reference signal from the first output signal, delaying the digital signal to produce a delayed digital signal, applying the delayed digital signal to the spectrally constrained impulse shortening filter to obtain a second output signal, comparing the second output signal to the

reference signal to compute an error signal, and computing coefficients of the spectrally constrained impulse shortening filter in an adaptive processor based on the error signal.

14. The method of claim 13, wherein computing the reference signal comprises: decoding the first output signal to form output data, and encoding the output data to form the reference signal.

15. The method of claim 14, wherein computing the reference signal further comprises applying a discrete Fourier transform to the first output signal prior to decoding the first output signal.

16. The method of claim 14, wherein computing the reference signal further comprises applying an inverse discrete Fourier transform to the encoded output data.

17. The method of claim 14, wherein computing the reference signal further comprises scaling the encoded output data with a set of scaling factors.

18. The method of claim 17, wherein the scaling factors are determined by: measuring received noise power spectral density, computing a desired spectral response based on the measured noise power, and computing the scaling factors so that the coefficients computed in the adaptive processor provide the spectrally constrained impulse shortening filter with a spectral response that matches the desired spectral response.

19. The method of claim 18, further comprising applying a discrete Fourier transform to the first output signal prior to decoding the first output signal and measuring the noise power spectral density at an output of the discrete Fourier transform.

20. The method of claim 17, further comprising applying an inverse discrete Fourier transform to the scaled, encoded output data.

21. A multiple carrier communication system comprising: a primary impulse shortening filter connected to receive a digital signal and to accept coefficients, a secondary impulse shortening filter connected to receive the digital signal, output an output signal, and pass coefficients to the primary impulse shortening filter, a reference signal generator configured to output a reference signal, a comparator connected to compare the output signal and the reference signal and output a resulting error signal, and an adaptive processor that computes coefficients for the secondary impulse shortening filter based on the error signal.

22. The multiple carrier communication system of claim 21, further comprising: a discrete Fourier transform connected to receive an output signal of the primary impulse shortening filter, and a decoder connected to receive the transformed output signal from the discrete Fourier transform.

23. The multiple carrier communication system of claim 22, wherein the reference signal generator comprises an encoder connected to receive output data from the decoder.

24. The multiple carrier communication system of claim 23, wherein the reference signal generator further comprises a scaling filter connected to scale the output data from the encoder using a set of scaling factors.

25. The multiple carrier communication system of claim 24, wherein the scaling factors are determined by: measuring received noise power spectral density, computing a desired spectral response based on the measured noise power, computing the scaling factors so that the coefficients computed in the adaptive processor provide the secondary impulse shortening filter with the desired spectral response.

26. The multiple carrier communication system of claim 24, further comprising an inverse discrete Fourier transform connected to receive the scaled output signal from the scaling filter.

27. A multiple carrier communication system comprising: a spectrally constrained impulse shortening filter connected to receive a digital signal and to accept coefficients, a reference signal generator configured to output a reference signal, a memory to store the reference signal as a predetermined signal, a discrete Fourier transform connected to receive the reference signal from the memory, a scaling filter connected to scale the reference signal using a set of scaling factors, an inverse discrete Fourier transform connected to receive the scaled reference signal, a comparator connected to compare the digital signal and the scaled reference signal and to output a resulting error signal, and an adaptive processor that computes coefficients for the spectrally constrained impulse shortening filter based on the error signal.

28. The multiple carrier communication system of claim 27, wherein the scaling factors are determined by: measuring received noise power spectral density, computing a desired spectral response based on the measured noise power, computing the scaling factors so that the coefficients computed in the adaptive processor provide the spectrally constrained impulse shortening filter with the desired spectral response.